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PROTECTION OF THE ATMOSPHERE: SECTORAL ISSUES

Report of the Secretary-General of the Conference

BACKGROUND

1. This paper has been prepared in response to decision L.12 of the Preparatory Committee at its second session, in which the Secretary-General of the Conference was requested "... to investigate further the interconnections between the issues of climate and environmental and developmental issues ... and cross-sectoral issues, and to report to the Preparatory Committee at its third session, in order to enable it to consider at that session the preparation of related proposals for discussion at the United Nations Conference on Environment and Development". Two papers were prepared in response. This paper analyses the major linkages, and the possible responses. A second paper, entitled "Protection of the Atmosphere: Options for Agenda-21" (doc. A/CONF.151/PC/xx) proposes a number of options for the considerations of the Preparatory Committee.

2. This paper includes a detailed analysis of possible responses in the energy and transport sectors, arguably the most important sectors as far as atmospheric issues are concerned. Policy responses which affect the atmosphere are presented in other papers also for the sectors of Oceans, Water, Forests, and Agriculture. Responses specific to the issues of Transboundary Air Pollution and the Protection of the Ozone Layer will be prepared for the fourth session.

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3. A number of important activities are now ongoing in intergovernmental fora, such as the Intergovernmental Negotiating Committee (INC), which will have major impacts on the response strategies developed for UNCED. A number of regional and international conferences have just taken place, or will do so before the end of this year, whose major recommendations will be taken into account in the options for Agenda-21 prepared for the fourth session of the Preparatory Committee. A preliminary list of these major inputs is found in Annex 1 to this paper.

4. The Secretariat would like to acknowledge the input of the members of the Atmosphere Working Party, and the Consultative Group in the preparation and the review of this paper. 1/

LINKED ATMOSPHERE PROBLEMS: CLIMATE CHANGE, AIR POLLUTION AND OZONE DEPLETION

5. The risks of climate change cannot be understood or managed without consideration of the larger context in which they occur, and the potential implications on economic activities in the energy, agriculture, forestry, and transport sectors.

6. Although it is usual to treat the problems of climate change, ozone depletion, and air pollution as separate phenomena occurring in isolated compartments of the atmosphere, these problems are all intimately and unavoidably linked together. They are linked by economic activities; by physical, chemical and biological processes; and they are also linked by the impacts of policy decisions made to reduce the risks of any one of these problems on the remaining two.

Economic Linkages: The Sources of Atmospheric Pollutants

7. Chlorofluorocarbons are also greenhouse gases. On the other hand, both air pollutants and greenhouse gases, and a part of the chlorofluorocarbons are emitted from the energy or related sectors. In many cases, the same activities also contribute to other environmental problems, including deforestation, land degradation, loss of biological diversity, degradation of fresh water resources, and ocean pollution.

8. The largest contributors to the emissions are the activities associated with the mobilization, conversion, and disposal of energy resources. The Scientific Working Group (WG I) of the Intergovernmental Panel on Climate Change (IPCC) has estimated that emissions from energy-related activity contributed about half of the warming effect of human activities during the decade from 1980 to 1990. The full fuel cycles of activities necessary to extract, transport, convert, use and dispose of energy resources produce a wide variety of emissions, including carbon dioxide (CO_2), methane, nitrous oxide (N_2O), and chlorofluorocarbons (CFCs) that trap outbound infra-red radiation from Earth's surface and enhance the natural greenhouse effect.

9. Energy-related activities also release large quantities of other trace gases. These include volatile organic compounds (VOCs), unburned hydrocarbons (HCs), carbon monoxide (CO), oxides of sulphur (SOx) and oxides

of nitrogen (NOx). Some of these have direct health impacts. SOx and NOx interact with water vapour in the atmosphere to generate acidic substances that are deposited on surfaces in both wet and dry form.

10. Chlorofluorocarbons (CFCs) emitted at the ground level gradually rise through the lower atmosphere, reaching the upper atmosphere after about a decade. They contribute to the greenhouse problem, and participate in various catalytic cycles that destroy the natural stock of ozone.

11. The economic connections to these three important problems are not, however, limited to activities in the energy sector. Human activities in the agriculture and forestry sectors are responsible for emissions of CO_2, methane, nitrous oxide, and carbon monoxide. Natural processes in forests may also release volatile organic compounds. Activities in the forestry sector leading to both deforestation and the conversion of forested areas to other uses contributed a quarter to a third of the warming effect of humans during the last decade. Agricultural activities also release large quantities of trace gases. The most important emissions in terms of these atmospheric problems are methane releases from paddy cultivation of rice and nitrous oxide emissions from the breakdown of nitrogenous fertilizers.

12. Other important sources of greenhouse gases include cement manufacturing and waste disposal in landfills. Cement manufacturing releases about 3 per cent of the anthropogenic CO_2 emitted each year. Landfills emit relatively small but significant quantities of methane.

Biogeophysical Linkages: Physical, Chemical and Biological Interactions

13. The three atmospheric problems are further linked by physical, chemical, and biological interactions among the pollutants. These interactions occur after the pollutants are released into the atmosphere. One important example concerns the role of tropospheric ozone. Emissions of HCs, VOCs, and NOx interact in the presence of sunlight to form ozone, a greenhouse gas, in the troposphere. The formation of ozone in the troposphere is accelerated by sunny weather. Ozone depletion in the stratosphere due to CFCs allows more ultraviolet light to penetrate to the lower atmosphere, where it enhances the formation of ozone.

14. Acid deposition which occurs in the presence of tropospheric ozone is much more likely to cause forest death than deposition occurring in the absence of ozone. Forest death which occurs as a result of acid deposition causes the conversion of stored carbon to CO_2, further amplifying the greenhouse effect.

15. Another important example of complex interactions involves carbon monoxide, CO. CO is not a greenhouse gas, nor an acid pre-cursor, nor an ozone depleter. CO is released when the oxidation of fuel resources is incomplete due to inadequate supplies of available oxygen. The two largest sources of CO emissions are automobiles and deforestation activities. Carbon monoxide attacks hydroxyl radicals (OH), the natural cleansing agent of the atmosphere which is also the principal sink for methane. Thus, activities which release CO accelerate the build up of methane and other pollutants in the atmosphere by removing or disabling the natural sinks.

16. Another example of a potential linkage between ozone depletion and climate change also involves the loss of a natural sink. The release of CFCs contributes to ozone depletion and thus to increasing penetration of harmful ultraviolet radiation at the Earth's surface. Most of this radiation will fall on the ocean, which covers three quarter's of the planet's surface. Floating near the surface of the ocean are large populations of small marine organisms called phytoplankton. The increased ultraviolet radiation is believed to adversely affect them. The effect could be a change in the species composition of the phytoplankton, with resulting effects on the whole marine food chain, and possibly significant reduction in the fixation of CO_2 to carbohydrates, reducing the ability of the oceans to act as a carbon sink.

Institutional Linkages: Organizational and Policy Connections

17. Perhaps the most important and complex linkages are those which connect the policy choices made on any one of these issues to their effects on the other two. Efforts made, for example, to limit the risk of acid deposition often focus on control of the emissions of SOx from coal-burning power plants. The principal method for controlling these emissions is to place flue-gas desulphurisation devices (called stack-gas scrubbers) on the exhaust pipes of the power plants.

18. These devices do reduce the rate at which oxides of sulphur are emitted but they result in increased CO_2 emissions for a given energy production, because the operation reduces the efficiency of the power plants. Thus policies which attempt to reduce the risk of one problem can worsen another.

19. This is not the only example of multiple effects of a single policy choice. Many have suggested that one of the best ways to reduce the risk of global warming is to substitute natural gas for coal because gas combustion releases about half as much CO_2 as does coal burning, per unit of energy supplied. Depending on where and how the gas is mined and transported, some of it may leak out of the collection system. A leak of only 3 per cent of the mined gas (which is mostly methane) would negate the CO_2 emissions advantage that gas enjoys over coal because methane is about 20 times more powerful as a greenhouse gas.

BIOGEOPHYSICAL LINKAGES BETWEEN ATMOSPHERIC PROBLEMS AND OTHER ISSUES

The Climate Connection

20. Climate change can contribute to the severity of other important environmental problems. While deforestation, especially in the tropics, is adding to the risk of climate change, climate change can increase the risk of forest damage. Increasing temperatures may shift the limiting conditions for a wide range of trees, crops and other forms of life faster than the wild species can migrate, and agriculture readily adapt to. In sub-tropical regions, deforestation and shifting patterns of rainfall may combine to reduce the net precipitation available to support traditional species, further accelerating the rate of forest loss. These will have impacts on the levels of biodiversity and on ecosystem stability also.

21. Climate change can also contribute to land degradation in several important ways. If precipitation patterns shift due to a greenhouse warming, areas that have traditionally supported rain fed agriculture, even at the subsistence level, may become less able to support food production and economic development. This will have an impact on women and areas where food production depends on female labour.

22. As temperatures rise and water resources shift, soils may dry out, resulting in increased oxidation of carbon resources. Alternatively, in other areas, more intense precipitation may increase soil erosion and siltation of dams and streams.

23. Climate change may have important impacts on the risks to biological diversity. As climate zones shift, specialized habitat areas that are already under pressure from human settlements will experience even greater stress. For some species, the conditions needed to support their life cycles may disappear. For others, it will be the increased competition with human activities. The result may be that many nature reserves and protected areas no longer offer habitats for the species they were established to protect, while there may be no alternative locations on which to place new reserves.

24. Climate change may also place new stresses on fresh water resources. In some areas, shifting patterns of rainfall and evapo-transpiration will simply reduce the amount of available runoff and groundwater recharge. Reductions in runoff may mean that the local strategies to reduce pollution by dilution can no longer be effective. Declining ground water recharge, either alone or in combination with sea-level rise, may cause salt water intrusions to contaminate water supplies. In other areas, increased demands for human uses will combine with changes in the natural endowment of water resources to reduce the volumes of water available to support natural ecosystems. In a few cases, given changing and uncertain regional climates, the demands for water to support national economic development schemes may be so large as to increase the level of intraregional or interregional tensions, worsening the risk of conflict between nation states and threatening other types of environmental disasters.

25. Climate change may have important impacts on ocean ecosystems. Recent research suggests that coral reefs are highly sensitive to small changes in ocean temperatures, and sea level rise. Extended episodes of elevated ocean temperatures appear to cause extensive bleaching in many marine coral. If the coral bleach out and die, they will be unable to protect many tropical islands, coastal zones and atolls from the severe weather of the open ocean. In addition, death of the coral will reduce the biodiversity of one of the richest ecosystems and natural communities on the planet, with appropriate impacts on the whole marine food chain.

26. Climate change may also negatively affect the prospects for achieving food security on our planet. This will be daunting enough as human populations increase from five billion to perhaps over 10 in the next century.

27. Finally, climate change will negatively affect the most vulnerable populations, those already at risk today - the poor, the old, and the very young. They are the most vulnerable to extremes in the weather, and to new

diseases that may arise or migrate in changed climatic conditions. They also have the fewest economic resources to mitigate the effects of climate change. While some have argued that climate change will have few serious impacts among the rich, for the poor, the old, and the young, climate change may mean the difference between survival and death. It will also increase the workload of women who need to care for these vulnerable groups.

The Ozone Connection

28. As mentioned earlier, stratospheric ozone depletion could have adverse effects on oceanic biota. If increased exposure to UV-B results as expected from ozone depletion, and if this exposure reduces the productivity of marine phytoplankton, the process could cause massive disruption in marine ecosystems, as phytoplankton are the base of the oceanic food web.

29. Ozone depletion is also likely to have important negative consequences on human health. The most widely discussed impact of ozone depletion will be increased incidence of skin cancers, especially among fair-haired, fair-skinned peoples. Less dramatic, but far more important globally is the likely impact of ozone depletion on the rate of cataract formation among both people and animals. Although cataracts are not considered a major health risk in the advanced industrial countries, they are a principle cause of blindness in many developing countries.

The Air Pollution Connection

30. Acid deposition in the presence of elevated ozone levels can increase the rates of forest damage, die back and crop losses. It can also reduce the productive capacity of land resources and limit fish productivity in streams and lakes. Combined with elevated local levels of respirable particulates, air pollution of this sort can place increased stress on the most vulnerable populations in both developing and industrialized countries.

THE NEED FOR AN ENERGY TRANSITION

31. There is general agreement that more sustainable and equitable development must involve radical changes in the modes of production and use of energy. These changes, which can reduce greenhous gas emissions, are important and justifiable on other economic and environmental grounds. The UNCED Preparatory Committee, at its second session agreed that energy, transport, agriculture and industry are especially important sectors in terms of development needs and environmental impacts.

32. Energy producers and consumers have always been guided by a few main concerns: cost, convenience, security of supply, and "environment" in various guises. The balance of attention given to these concerns has led to a dominant culture of energy production, conversion and consumption which is remarkably uniform across the urbanised and industrialized parts of the world. For modern forms of energy (as opposed to traditional biomass fuels) this culture is based on a pre-occupation with energy supply, large-scale centrally-organized technologies, and a planning paradigm which considers that supplies should be increased to meet whatever level of demand arises from

activities and the national economy. The technologies which use energy (vehicles, buildings and their services, steel mills, etc.) have evolved in step with this predominant culture.

33. We now recognize that these attitudes have led to a global energy system and growth trends which are neither sustainable nor effective in supporting the development needs of the majority of the world's population. The attention given to the traditional concerns has to change, to such an extent that the energy culture itself has to be transformed, through a transition to sustainable patterns of energy use and production.

34. With the environment, the production, transport, conversion and consumption of energy has become the principal cause of many of the most severe forms of environmental damage and risk - globally, nationally and locally. The four types of environmental impact which require the most vigorous responses are:

a. The energy sector is responsible for the largest share of the risks of climate change. The greenhouse gases emitted from this sector will need to be stabilized and reduced;

b. Acid depositions from fossil fuels are causing severe impacts on large areas of forest, soils, water bodies and aquatic life;

c. Air pollution in many cities has reached critical levels with consequent harm to human health. Vehicles are largely to blame;

d. Smoke from burning biomass fuels in the home exposes some 500 million people in developing countries to serious risks of eye and lung diseases as well as some forms of cancer. The burdens of gathering biomass fuels, on which some 2.5 billion people depend for their basic energy needs (on scarce and/or rapidly declining resources in many places), also affects health and can severely restrict the time available for agriculture and sustainable land management practices. In this case, the lack rather than an excess of modern energy provision is having severe impacts on women and children, the poor, food security, land degradation and education.

35. Another issue is the high cost of the conventional supply-dominated paradigm. In many developing countries the energy sector is not only failing to support material development; by devouring scarce capital it is putting a brake on it. In the developing countries as a whole, annual investments on energy supply are now around $85 billion a year ($150 billion including the petroleum exploration sector), of which electricity supply accounts for some $70-75 billion. The World Bank has estimated that electricity expansion plans in 70 developing countries will require capital investments in the region of $1,000 million during the 1990s. This figure is about 50 per cent above present rates of power sector investment and close to the total indebtedness of those countries. Unless there are radical improvements in power sector performance - or shifts towards available, lower cost options - these investments needs will simply not be met under any plausible set of conditions.

36. In developing countries substantially increased energy consumption will be required to satisfy their development aspirations. Yet in many such countries even relatively high levels of energy investment are failing to meet development needs. Power and other energy shortages are expected to continue (or worsen) well into the next century, with harsh impacts on productive sectors and vulnerable groups. Meanwhile, the energy needs of millions will remain largely unmet. In some countries, for example, the numbers of non-electrified households is actually increasing despite decades of high-cost, centralized rural electrification programmes.

37. However, these multiple difficulties can also be seen as a great opportunity for positive change. Technologies exist for creating energy systems which are more efficient, lower cost, more self-reliant and therefore secure in terms of access to resources, and environmentally benign. Given time for their improvement and wide-scale implementation, they even hold out the chance of eliminating the most severe environmental limits on energy growth while allowing large increases - most importantly, in the less developed world - of what consumers actually need from the energy sector: basic energy services such as warm or cooled homes, adequate light, rapid and convenient transport, and power to replace hard physical labour.

38. These technologies are essential for all countries: for the rich because they are the biggest polluters and must rapidly reduce their most serious emissions; for the less developed because they are needed to help sustain material development at affordable costs. From a developing country perspective, the fact that they will help reduce global warming and other environmental risks may be seen as an important bonus but cannot in the immediate future be accepted as a primary consideration if it harms development prospects. In all countries, though, many efficient and clean technologies have such low net costs that they offer a "bonus" strategy rather than a "no regrets" option.

39. The major challenge of energy in the 1990s and beyond is to grasp and sustain the opportunities offered by such technologies. However, there should be no illusions that this will be quick or easy. Indeed, the challenge is daunting. It will involve far more than mouthing easy slogans such as "promote energy efficiency" or "develop clean and renewable energy sources". It requires new social objectives for the energy sector. It demands the involvement of a much wider constituency of actors, including consumers, women, industry and business, financial institutions, local communities and international organizations, as well as government planners and conventional energy supply utilities. It means overcoming many entrenched and powerful interests in order to switch the emphasis from the centralized supply paradigm towards more decentralized and varied solutions. And it calls for making and orchestrating difficult choices amongst a large number of control strategies, ranging from internationally-agreed energy taxes and emission targets, through a panoply of national regulations and fiscal measures, to economic and technical assessments at the micro-scale of the individual producer and consumer. At all levels, rather little is known about the practical difficulties and most effective forms of implementation.

40. In short, the challenge is to create nothing less than a new energy culture designed to pursue alternative, lower cost, higher benefit and more sustainable energy futures. There is no question that such futures can be made. The question is whether the will exists and creative forces and incentives can be unleashed to embark and achieve a transition, in time.

TOOLS FOR SUSTAINABLE ENERGY DEVELOPMENT

41. Many of the technical and planning components of the tools available to meet this challenge can be dealt with by national governments at low costs and with little or no need for international assistance, conventions or other agreements. Significant aspects of the required programmes - including some capacity development, technology development and transfer, normative measures, economic and policy instruments, information, and institutional issues - can be met in this way, even by least developed countries.

42. With other aspects, many governments and other national organizations in the energy field will need substantial technical and financial assistance from external sources, depending on their economic circumstances and management capacities. On a global scale, the need for additional assistance is large in terms of present aid flows for the energy sector but small in terms of total energy sector expenditures. Changes in the objectives and methods, and additional funding, for United Nations agencies and the international donor community, will undoubtedly be required.

ENERGY EFFICIENCY

43. Energy efficiency is now widely regarded as the key area for action. It has the technical potential for producing multiple and permanent benefits, quickly. The near-term technical potentials for reducing energy demand to meet a given level of useful energy service are very large and the economic or cost-effective potentials at present energy price levels are large.

44. A number of recent studies come to the conclusion that, worldwide, it is possible to achieve energy savings of 40 per cent or more with currently available technologies. Furthermore, a 50 per cent reduction in global "business as usual" energy demand growth over the next two decades from end-use efficiency improvements is a reasonable and practical goal. Savings beyond that point are more speculative and would require the adoption of measures which are not currently cost-effective, but which may become so due to technical progress.

45. The cost-effectiveness of energy efficiency measures and potentials is more difficult to estimate. It varies considerably by country since it depends heavily both on the mix of end-uses and of technologies employed, as well as on energy prices, interest rates, etc. Analyses differ considerably, even for the same country or national sector and the same energy price assumptions. Nevertheless, several recent studies of industrialized countries have estimated that, when allowance is made both for growth in demand and saved investments on energy supply facilities, absolute reductions of 15-30 per cent in CO2 emissions could be obtained within 10-15 years, for negative net costs, mainly through the vigorous promotion of energy efficiency.

46. There is an urgent need to improve on these costing studies, especially for developing countries, with the aim of gaining consensus about the costs, potential savings and resulting environmental impacts for various levels of efficiency implementation. These cost curves can then be compared with those for other possible measures, including renewable energy and conventional supply options, as well as forestry, agriculture and other land use measures in the context of greenhouse gas reduction. The cost comparisons can then be used as a basic tool for designing least-cost policies and plans for developing the energy and other relevant sectors.

47. In particular, the costing exercise for energy efficiency (and renewable energy) must include (1) financial savings from reduced investments for conventional energy supply, (2) expected efficiency and cost gains on the supply as well as the demand side, and (3) the costs of policies for implementing each measure, such as information and demonstration programmes, etc. The analyses must be based as far as possible on actual experience rather than desk estimates, which can for example easily overstate the case for efficiency measures. This may require intensive data gathering - for example, by audits of the manufacturing sector - and will have to be supported by substantial technical assistance programmes.

48. For developing countries and economies in transition, the potentials of economic energy efficiency improvements are likely to be at least as great as in the industrialized nations. In many key sectors, notably energy-intensive manufacturing, electrical end-uses and transport vehicles, energy is now used much less effectively than in the industrialized countries.

49. More importantly, energy efficiency gives developing countries a opportunity to "leapfrog" the inefficient development history of the industrialized world by installing modern and efficient technologies as they develop and increase their capital stocks. However, major changes in arrangements over access to technologies and financing will be required for this to happen.

50. Large economic energy savings can also be made on the energy supply side, most notably in electricity generation which accounts for a large proportion of energy-related atmospheric and other pollutants, including greenhouse gases, in most countries, through options that are technically feasible and generally much cheaper than capacity expansion. If these gains were to be achieved the need for new capacity in the mid-term future would be halved, saving literally hundreds of billions of dollars for capital-scarce and indebted nations.

51. Three cautionary remarks about the implementation of efficiency are necessary. First, the potentials will not be realized without an adequate and supportive technical and managerial environment. This point is of particular importance for less developed countries and emphasizes the need for a comprehensive approach in efficiency programmes.

52. Second, technical efficiency gains can be wiped out by consumer behaviour and aspirations. In many industrialized countries recent trends towards larger cars and refrigerators, for example, have more than offset substantial

improvements in the energy economy of these technologies. This emphasizes the need for policies which also influence consumption patterns in addition to merely promoting efficient technical performance.

53. Third, some of the most dramatic improvements in energy efficiency have come from advances and investment decisions which have nothing to do with energy per se. In manufacturing, particularly, large reductions in energy use per unit of output have been due to the development of and investments in machinery and processes which are more productive in the broadest sense. Economic, industrial and trade policies which stimulate and attract investment, new ventures and entrepreneurship may do as much to promote energy efficiency as policies directed to efficiency alone.

54. In every society there is a host of market and non-market barriers which slow or prevent the adoption of efficiency measures. These exist at all levels: the consumer, energy equipment manufacturers and suppliers, energy utilities, financial institutions, governments and international donor agencies. Some barriers are easy to remove; others are more intractable and politically sensitive. Understanding the particular barriers which apply to each country and sector, and designing the best mix of precise measures to overcome them, is a formidable but vital task.

55. Annex 2 lists the major barriers to energy efficiency and the measures which can help overcome them. It underlines three main points. First, higher energy prices are only one of the main instrument for promoting more efficient energy use. Second, many innovative measures exist and have been used successively to overcome the barriers. Third and most importantly, while from a developing country perspective some of these measures require substantial funds and/or technical assistance, many can be adopted with low costs by national governments acting alone and will frequently improve overall economic performance.

56. Two broad actions can do much to mobilize governments and other actors into adopting these measures. The first is the development of cost and supply curves and the adoption of least-cost planning principles, as noted above. The second is to set targets at various levels. For example:

a. National reduction or stabilization targets have been set by a number of industrialized countries for net carbon dioxide emissions. These will be elaborated by the INC in its formulation of a Climate Convention and are not discussed further here. Reduction targets for other emissions (e.g. SO2, NOx) are also a well established control measure in industrialized countries and regions with implications for energy efficiency;

b. Targets based on progressive reductions in energy intensity or emissions intensity for key sectors (i.e. per unit of physical production or value added) can be adopted by all countries and may be more appropriate for developing countries;

c. Targets in the form of performance standards for key technologies have been used effectively by many countries. Some targets of this kind are appropriate for developing countries and could assist rather than hinder development prospects;

d. Targets for the provision of basic energy services to improve the quality of life, such as the percentage of homes with electric lighting, might also be considered by developing countries. Such targets would not only help to improve welfare, especially of the poor; they could do much to redirect the thrust of energy development from false hopes in "trickle down" towards diversified, low cost and clean technologies for meeting basic needs directly.

ENVIRONMENTALLY SOUND ENERGY SYSTEMS

57. In addition to energy efficiency measurers, the energy transition must include a major shift toward environmentally sound energy systems (ESES). This shift includes switching to cleaner fuels, advanced fossil fuel conversion systems, and most importantly renewable energy.

Switching to cleaner fuels

58. There are several well-recognized technical options for reducing local and transboundary air pollution, and greenhouse gas emissions, by switching from high-emission to lower-emission fossil fuels: for example, high- to low-sulphur coal, and coal --> oil --> natural gas. The feasibility and economics of doing so vary greatly by country, since they depend on many factors such as technical experience, resource endowments, infrastructure (e.g. gas pipelines), capital availability, economic ability to import, and the prices of alternative fuels. Other options include alternative pollution clean-up technologies such as flue-gas desulphurisation (though this does not apply to greenhouse gas emissions).

59. Key issues for programme areas include the need by many developing countries and economies in transition for substantial financial and technical assistance in order to make optimum decisions; steps to improve access to these technologies on favourable terms; and levels of R & D funding for alternative clean technologies.

Advanced Fossil Fuel Combustion

60. A number of countries with large fossil fuel, and in particular coal reserves will make use of those resources. It is imperative that this is done using the most efficient and least polluting conversion technologies. Several technologies already exist, and these need to be made available to countries which need them on preferential bases. New technologies are being developed, and this should be continued and accelerated. Furthermore, it is essential that the capacity to develop and implement such technologies is also available in the developing countries.

Renewable Energy Sources

61. The attractions of new and renewable sources of energy (NRSE) as an escape from environment-development conflicts are obvious. Indeed, many would agree with the World Commission on Environment and Development that renewable energy "should form the foundation of the global energy structure during the 21st Century". As the costs of some major renewable technologies continue to fall, a growing number of energy analysts are beginning to see that the WCED's "should" can become "could" - or even "will".

62. At present, however, renewable energy sources deserve their description as options that everyone likes, but most ignore. Although several countries have taken significant steps to implement renewables - notably geothermal power, biomass-based alcohol, solar water heating, wind, tidal power and landfill gas - the achievement is patchy and there have been many failures. On a global basis their contribution is small: excluding traditional biomass (14 per cent) renewables accounts for little over 7 per cent of global primary energy supply, and that almost entirely from conventional Large-scale hydropower.

63. This slow development has not been due to a lack of national or international good intentions. Most countries have renewable energy organizations and R & D programmes, while the Nairobi Plan of Action (NPA) was established in 1981 as a result of the United Nations Conference on New and Renewable Sources of Energy, as a comprehensive international effort for stimulating the development and utilization of renewable energy sources. But the decade since then has largely been lost due to falling energy prices and lack of clear financial commitments and institutional support.

64. Most notably, funding for R & D efforts has generally been small and declining. For example, public spending on renewables R & D by members of the International Energy Agency fell from just over $1.5 billion in 1981 - the year of the NPA - to around $500 million in 1989. In that year renewables accounted for 7 per cent of total IEA energy R & D expenditures of $7.34 billion, with energy efficiency at 5 per cent, compared to 15 per cent for fossils, 12 per cent for nuclear fusion and 47 per cent for fission.

65. A reversal of this trend is the principal recommendation by the United Nations Solar Energy Group on Environment and Development in its preliminary statement. The group echoes the belief of the WCED by concluding that if global economic growth is built on energy efficient technologies, "a large fraction of energy can be provided from renewable sources. We believe that this should be our underlying goal". However, the Group emphasizes that achieving this through the rapid diffusion of NRSE depends on energy policy decisions by governments and calls for firm actions on several fronts.

66. Foremost amongst these is the need for increased and sustained research efforts. Although some NRSE technologies are already competitive, much larger research and development efforts (in the United Nations Solar Group's view, on the scale of nuclear R & D in the 1950s and 1960s) would certainly result in lower costs and better availability and reliability, especially for the cutting edge technologies such as photovoltaics and advanced biomass conversion to liquid fuels and electricity. Recent figures indicate that the price of renewables have already come down considerably, and are projected to go down even further, assuming continued R & D efforts.

67. Other key recommendations of the United Nations Solar Group are as follows:

a. The adoption of global and/or regional targets for contributions by NRSE (other than large-scale hydro and traditional biomass); and of negotiated national targets within this overall framework;

b. A minimum percentage of aid funds from bilateral, multilateral and international agencies devoted to the energy sector to be allocated to NRSE projects (excluding large-scale hydro), the percentage to increase over time. The same should apply to grants and loans by international development banks;

c. Public funding of NRSE research and development should be increased by at least a factor of three, on average, within five years.

68. Whereas some systems can be implemented on large scales by existing, centralized energy supply organizations, there is a very large scope for small-scale, stand-alone systems in all countries, especially in rural areas beyond the reach of conventional supplies. This means that decisions to use renewables, the selection of technologies amongst many possibilities, installation and operation, will be in the hands of a multitude of dispersed and varied local communities and enterprises. Government energy policy and planning, capacity building, information, training and other issues of technology transfer and assistance must be geared to this broadening and dispersion of actors in the business of energy supply.

69. Some of the most promising renewable technologies involve advanced forms of biomass conversion to liquids, gases and electricity. The production and use of many forms of biomass are being considered. There are, however, important economic an environmental implications which must be addressed, concerning the competition between different land uses; impacts on biodiversity and soils; implications for rural income, effects on women, employment and broader development prospects; and possibilities that vulnerable groups will lose access to vital biomass resources, or to land, by inappropriate energy plantation schemes. These issues need to be scrutinised carefully by integrated and comprehensive studies, including the early participation of all segments of local society, before irrevocable commitments are made substantial biomass energy projects.

70. A particular problem area is the traditional biomass consumption in developing countries. Much of this is unsustainable for the resource base, particularly in the urban areas. This needs to change by encouraging the use of alternative, modern fuels, based either on biomass or fossil fuels. This change may be slow, since it can only be affected by the broad development process itself. Some biomass use, however, is based on sustainable practices, which are indispensable for farm incomes, and this needs to be sustained and expanded. Much of biomass consumption comes as a byproduct of agricultural clearing. This will diminish as agriculture becomes more sustainable, and consequently alternatives will have to be found.

71. Biomass energy also has a strong bearing on afforestation as a means of combating global warming. Tree plantations will fix atmospheric carbon only while they are growing; once mature they will act as a carbon store and not as a sink, and their value for this purpose will be over. If they are felled their carbon will be released back to the atmosphere unless this is pre vented. Preventive methods include high-cost burial and use as timber and other long-lived wood products. However, potential national and world markets for such products are limited, while vigorous carbon-fixing afforestation schemes could quickly approach these limits. Experience in several developed

and developing countries shows that tree planting rates can decline rapidly when production exceeds market demand so that prices fall. Furthermore, apart from the limited scope for afforestation in sparsely populated regions for other environmental reasons (e.g. watershed protection in remote upland areas), large-scale afforestation schemes, if they are to be maintained success fully, are bound to be designed for multiple purposes. In other words, the trees will be harvested eventually.

72. One of the best solutions to this dilemma would be to find, new markets for tree biomass which do not result in (net) carbon releas after harvesting. Biomass conversion for energy is such a market. Each ton of harvested wood converted to high grade energy would replace the combustion of an equivalent amount of fossil fuel, so that the net carbon release would be approximately zero. Integrated studies of afforestation and biomass energy systems to examine these implications, in a variety of typical regions are needed.

THE TRANSPORT SECTOR

73. The transport sector raises in particularly acute form both the conflicts between energy, environment and development and the wide ranging responses that might be applied to them. The discussion focuses on the automobile as the form of transport which raises these issues most acutely.

74. The potential for growth of car ownership, travel, energy use and associated harmful emissions is enormous. There are now over 400 million cars in the world, providing incalculable benefits in terms of quick and convenient travel for the minority who own them, 80 per cent of whom are in the OECD countries. Most of the world's population who do not have a car would like one; and with development many will get one.

75. The potential for reducing the environmental impact of this growth is also enormous. First, technical measures can greatly improve the fuel economy of the car with roughly proportionate reductions in emissions per mile driven. The fuel economy of the most efficient new cars in OECD countries is about twice that of the average fleet. A recent analysis suggests that a 50 per cent improvement in performance for the world-average car by 2010 would lower the expected growth in global car fuel consumption from plus 0.5 per cent a year to minus 0.3 per cent.

76. At the same time, many technical measures are being developed - and some are being applied - to reduce automobile exhaust emissions. Clean-up technologies such as catalytic converters add substantially to vehicle costs but are considered worthwhile by many industrialized country governments, and broadly accepted by consumers, as a means of meeting emission reduction targets. But these measures have not been introduced without political controversy. Their acceptance by developing country governments and consumers is less assured unless funding and technical assistance is available.

77. In the medium to long term several alternative low- or zero-emission fuels should become available, but only if large R & D efforts are supported and sustained, perhaps driven by firm emission reduction targets. Liquefied petroleum gas (LPG) and compressed natural gas (CNG) are already available; ethanol and methanol produced from fossil fuels or biomass; electric

propulsion based on the present generation mix or renewables such as solar and wind power; and in the longer term, hydrogen derived from biomass or solar energy are all feasible alternatives.

78. However, car manufacturers who must implement these technologies view them cautiously. Right now, even the relatively modest advances in fuel efficiency appear to them as high risk ventures since there are no obvious market demands. Most fuel-efficient prototypes are light weight, low power, for four or fewer passengers, and have manual transmission. Even if they cost no more than conventional models, with present fuel prices the cost of fuels is only a small part of the annual cost of owning and running a car in all of their main markets. Consequently there is no clear price signal for consumers to prefer a high-efficiency vehicle. This point is supported by recent trends in most OECD countries, where improved efficiencies of new car models have been wiped out during the 1980s by shifts to larger cars as well as increases in annual car mileage.

79. The development and mass diffusion of energy-efficient, low-emission automobiles will therefore demand sustained and politically controversial efforts to introduce or improve on a mix of regulations and market-based policies, such as:

a. Performance standards and targets for manufacturers, including stricter measures where these are already applied. This may require international agreements because of the global nature of the automobile market. An advantage of such measures is that agreements must be reached with very few car manufacturers compared to hundreds of millions of car buyers;

b. Differential taxes, such as higher taxes and/or annual registration fees for high-consumption, high-emission cars, perhaps combined with low taxes and fees for efficient and clean models;

c. Higher taxes on automobile fuels, especially in countries with presently low retail prices.

80. These measures may prove insufficient to control mounting and some times critical levels of urban air pollution due to the car and other road vehicles. Nor will it do anything to curb the growing costs of and discontent over traffic congestion in most of the world's major cities. Further and far-reaching policy measures will be needed to reduce these problems by restraining the car and encouraging more space-efficient, energy-efficient and less polluting transport modes, such as travel on foot, bicycle, bus, rail, metro and forms of light rail. A large range of consumption limitation policies will be required:

a. Outright bans or higher charges for using or parking cars in certain areas. Electronic monitoring technologies are available for applying these penalties automatically;

b. Tighter physical restrictions on road space for cars (bus-only lanes, reduced parking space, denial of road lanes to cars with fewer than a certain number of occupants, etc), combined with extra provision for bicycles and public road vehicles;

c. Promoting alternative, low-emission automobile fuels, particularly in areas of high concentration of vehicles;

d. Greater investment on public transport infrastructure;

e. Subsidies for public transport where necessary to reduce operating costs so that fares can be held down and the quality and frequency of services improved.

81. In the longer term, in many countries, the need for personal mobility could be reduced significantly by improved telecommunications (telecommuting, electronic shopping, etc) and by the spatial redistribution both of living and work/production locations. The degree to which these changes must be engineered for environmental reasons, or will occur spontaneously (in part due to the restrictions outlined above) is, at present, highly uncertain.

82. Finally, if all the technical and other measures described above prove inadequate for meeting social and environmental objectives, aspirations to drive (alone) in a large, fuel inefficient car may have to be modified by sanctions - or will be modified by evolving social norms.

83. Other forms of transport than the car require responses broadly in line with those outlined above. In the present context, road freight and aircraft are the most important owing to their rapid growth in most countries and substantial contributions to air pollution and greenhouse gas emissions.

MOVING TOWARD THE ENERGY TRANSITION

84. The creation of a sustainable energy future will require concerted actions on many fronts by many institutions. In the final analysis, it is national policies and actions, supported by the public, that must change so that the transition to sustainability takes off at the required speed in the right directions.

85. The needs for support, and the responsibility and opportunity for initiating change, differ widely across the main regions of the world.

86. In particular, the industrialized countries are in a position to:

a. Take a lead in making tough policy decisions to stabilize and then reduce greenhouse gas emissions and other atmospheric pollutants;

b. Take a lead in financing programmes and actions for sustainable energy developments in all regions of the world, including measures to relieve debt burdens and improve the terms of financial flows to other regions of the world;

c. Take a lead in research, development and demonstration of energy efficiency, cleaner fossil fuel supply systems, and renewable energy sources;

d. Take a lead in improving energy efficiency worldwide by imposing standards on the manufacturers of internationally traded goods such as cars and refrigerators, etc;

e. Improve genuine cooperation with other regions in R & D and technology transfer, including improved and assured access to innovative technologies.

87. For developing countries and countries in transition the main need is to establish policies across a broad front which help to promote sustainable (energy) development and to build up their human and institutional capacities to support local initiatives and joint initiatives with other countries and international agencies.

Capacity Development and Technology Transfer

88. For countries which stand to benefit most by them, technology transfer must be seen as a process of technology development and capacity building in the broadest sense and not just in terms of technical hardware.

89. In the energy-environment context, the priority need for developing countries and countries in transition is to strengthen and broaden energy policy and planning capacities at national, sub-regional and local levels. The objective should be to build up human skills, institutions, information and analytical capabilities not only to assess and absorb desirable technology from outside but also to develop it locally. Once the technologies are available, a sound infrastructure for implementing, maintaining, replicating and adapting the technologies and technical systems is essential.

90. Large and sustained flows of funding and technical assistance will be required to build up the scientific, technological, managerial and administrative capacities of many countries. International agencies can go a long way towards meeting these needs by:

a. Establishing and supporting local research and development, including government, corporate and non-governmental capacities, at then national or regional levels. Models of regional institutes for energy research, training and coordination exist in Asia and Latin America, but efforts are frustrated by lack of funding;

b. Helping to improve information flows on current research and development, applications and experience - including successes and failures - of programmes and projects;

c. Supporting training on technologies, technology assessment and evaluation, and energy policy-making and planning;

d. Assisting local as well as central governments on a wide range of energy policy, pricing and planning issues, with special emphasis on energy efficiency, renewables and other alternatives to conventional supply-side developments, such as, for example, those based on indigenous knowledge and practice;

e. Providing advice, and funding where necessary, to the corporate sector as a key agent for R & D, production and dissemination of sustainable energy technologies. The encouragement of North-South and South-South joint ventures is an important option;

f. Reforming international legislation and/or establishing other forms of agreement on patents and intellectual property rights to meet the needs for preferential and assured access by developing and transitional countries to environmentally sound technologies. GATT negotiations could be initiated to resolve these issues.

Some Institutional Issues

91. International institutions are an important component in the overall strategy of sustainable energy development. At present, there is no international institution with a broad global mandate for energy. Within the United Nations system the International Atomic Energy Agency (IAEA) is the only organization with a specific, though limited energy mandate, although many United Nations agencies have their own energy programmes. Broad-based, regional energy coordination institutions have been established in many regions.

92. National and international development assistance agencies and banks also play a crucial role in the energy sector, with an increasing focus on environmental issues and sustainable energy development. Since they are presently the main agents for financial transfers and play a large part in technology transfer and other forms of assistance, they are considered separately below.

93. A substantial number of international (and national) NGOs are also active across the range of sustainable energy development, often working closely and with good effect with governments, international institutions and the corporate sector as well as the general public. Several international NGO networks have been set up to coordinate and promote these efforts, but in developing countries particularly NGOs generally suffer from a lack of resources, coordination and outreach. There is a need to encourage NGO involvement, especially in developing and transitional countries, both in national planning efforts and the implementation of project activities.

94. The following suggestions have been made for the establishment of new international institutions in the field of sustainable energy. These proposals might be considered in terms of "low" funding models (i.e. mainly with a catalytic and supportive function) or "high" funding models (i.e. as above, but also with substantial funding for technical assistance and technology transfer, and project implementation, etc). Low-funded institutions may develop to become high-funded organizations and/or require additional funds to support regional counterpart institutions. In all cases, secure funding for a reasonably long period would be essential if the institutions are to establish themselves successfully.

a. Global Energy Efficiency Mechanism (GEM) has been proposed to initiate and strengthen national energy-efficiency efforts, particularly in developing countries, as a non-governmental organization working outside of the United Nations system but perhaps associated with the United Nations through a sponsorship arrangement;

b. Network of International Research Centres of Excellence on NRSE. The United Nations Solar Group is expected to recommend that proposals to establish this network should be implemented;

c. International Renewable Development Agency. The United Nations Solar Group is expected to recommend the establishment of such an agency within the United Nations system. Its proposed mandate will be to work in close collaboration with existing international, national and non-governmental organizations with a mandate to enhance NRSE utilization worldwide;

d. A United Nations agency for sustainable energy. Another possible option is to establish a lead United Nations agency or programme with a broader mandate than any of those outline above; i.e. to include all aspect of sustainable energy development.

95. Multilateral and bilateral development agencies are and will continue to be key agents for the funding and implementation of energy projects in developing countries. Yet they have faced criticism that they have not dealt adequately with energy and environment issues generally, and in particular with energy efficiency and renewable energy. Most such institutions have been conducting thorough revisions of their environment and energy policies and it will be some time before this can be reflected in project and funding portfolios. Furthermore, most of these agencies have very small staffs with responsibility for specific sectors such as energy, and find it genuinely difficult to administer the many small-scale initiatives which are required for most national energy efficiency and renewable energy programmes.

96. Possibilities to improve the situation include:

- the number and quality of projects and funding for efficiency and renewables, and supportive measures in the fields of policy and institutional strengthening, be greatly increased;

- donor assistance do more to improve the performance and capacities of energy institutions in developing and transitional countries;

- donor agencies find mechanisms which allow them to administer and support many small-scale and diversified projects, such as working with and passing funds through local institutions; - etc.

FINANCIAL NEEDS FOR ENERGY DEVELOPMENT

97. For developing countries and countries in transition, large additional funds will be needed to finance the actions outlined above and help them to get on a more sustainable development path. Most of these will be of an investment character, reducing economic returns. In supporting such development, the funds will be paid back to the global economy many times over in the form of reduced investments and borrowing for energy supply expansion, quite apart from the incalculable benefits from slowing the rate of global warming and other forms of environmental protection.

98. Decisions are also required on the various options available for raising these funds, and on what type of body(ies) should control and administer them. Broadly speaking, fund-raising mechanisms related directly to the energy sector fall into two classes: measures designed solely to raise revenue (e.g. small energy or carbon taxes) and those which are also designed to dampen energy demand and/or force shifts to lower emission energy sources (e.g. large energy or carbon taxes). Some background information on these issues may be useful.

99. First, the effects of large energy/carbon taxes as a strategy for reducing energy demand and emissions are still poorly understood. Second, substantial revenues can be raised by small levies on energy use. For example, a levy of 3 per cent on present OECD fossil fuel consumption would be sufficient to raise approximately 10 billion dollars a year. This levy would be within the range of monthly oil market price fluctuations, and the effects on consumers would hardly be noticeable. Third, the interests of the energy producing countries have to be considered.

100. Fourth, present levels of funding for energy assistance to developing countries are small compared to expenditures by these countries on energy. Considering all developing countries, the annual costs of commercial energy for consumers have been estimated at about $450 billion a year. Loans for energy sector capital investments are now about $85 billion a year, of which $70-75 billion is for the electricity sector. Most of these sums are borrowed from commercial banks, which have been reducing their available funds for this type of borrowing. The remainder - of the order of $10 billion a year - comprises loans from multilateral and bilateral development banks and donor assistance agencies. Finally, energy assistance which comes "free" in the form of grants, etc., totals around $500 million a year. This is little more than 0.1 per cent of the $450 billion spent by developing countries on commercial energy supplies.

101. Fifth, there are important issues concerning the present absorptive capacities of recipient countries coupled with the willingness of donor agencies to provide assistance.

Note

1/ This paper was prepared on the basis of preliminary versions of two technical papers prepared for UNCED by the Stockholm Environment Institute, in collaboration with the Tata Energy Research Institute in New Delhi. The final versions will be made available to the Preparatory Committee at the fourth session.

ANNEX 1: PRELIMINARY LIST OF MAJOR INPUTS TO BE CONSIDERED

Intergovernmental Activities

1. Intergovernmental Negotiating Committee on a Framework Convention on Climate Change (INC/FCCC)
[ongoing activity]

2. Biodiversity negotiating forum
[ongoing activity]

3. Intergovernmental Panel on Climate Change (IPCC)
[ongoing activity, deadlines for specific activities, reports]

Other United Nations Activities

4. United Nations Committee on New and Renewable Sources of Energy Report
[progress reports already available, final report by end of November 1991]

5. Helsinki Symposium on Electricity and the Environment (IAEA, WHO, UNEP, CEC, ...)
[International Meeting, Report - May 1991]

6. WHO Commission on Health and the Environment (WHO)

7. Second World Climate Conference reports (WMO, UNEP,...)
[available]

8. United Nations-ECE, Energy-2000

9. Bergen Report (United Nations-ECE)
[Final report available]

10. Tlateleco Platform (United Nations-ECLAC)
[Final Report available]

11. Ministerial Conference, Bangkok (United Nations-ESCAP)
[Final report available]

12. Regional Conference for Africa (United Nations-ECA)

13. Regional Conference for West Asia (ESCWA)

14. Climate Change Costing Programme (UNEP)

Other International Activities

15. Asian Energy Institute's 11 Country Climate Costing Study
[first final draft available in July, Final Report by November 91]

16. International Conference on Coal and the Environment (OECD)
[November 91]

17. Greenpeace Climate, Energy work
[Final report by November 91]

18. SEI's Climate Assessment Project
[???]

19. OECD's Energy Strategy
[various reports available, Specific Agenda-21 ??]

20. World Energy Council, Commission on Energy and the Environment
[Draft Report available by end November 1991]

21. Energy Technology and the Environment (ETE-21)
[Interim Report available. Final by end November 91]

22. Sustainable Energy Development Conference, Copenhagen, Denmark (April 1991)
[Report of Meeting available in May 1991]

National Inputs

23. United States of America Proposal on Global Energy Efficiency Programme

24. National Reports, as they become available ...

ANNEX 2: BARRIERS TO ENERGY EFFICIENCY AND MEASURES TO OVERCOME THEM

ENERGY CONSUMERS

The Ignorant

Consumers are unaware that they can save energy (and money), or how to do so. Mainly small consumers (households, small businesses, etc).

Measures: Education and information. Demonstration. Energy audits (compulsory/voluntary, with or without grant aid). Third-party contracting (efficiency installation by specialist firms which recover their costs by splitting with the consumer the money saved). Energy labelling of appliances, dwellings, vehicles, etc.

The Poor and First-cost-sensitive

The initial investment is too large, even though the efficiency measure will pay back quickly through reduced energy payments.

Measures: Hire-purchase, leasing and rental schemes; e.g. by the supply utility through its bills, or equipment supplier. Third-part contracts.

The Indifferent

Energy costs are a small part of total costs.

Measures: Performance standards for equipment, applied to relatively few manufacturers rather than millions of consumers. Higher energy prices, progressive tariff structures, tariff penalties if loads are exceeded. Education and information.

The Inheritors of Inefficiency

Consumers who cannot alter/change equipment and have no part in the initial investment decision: e.g. tenants versus landlords and architects.

Measures: Education of initial investors. Performance standards. Equipment labelling to help consumers influence initial investors, landlords, etc.

The Uncertain

Uncertainty about future energy prices makes it difficult to estimate costs and benefits of efficiency improvements.

Measures: Stabilization or slow change in prices. Financing of investments and recovery of funds at guaranteed rates.

EQUIPMENT MANUFACTURERS

The Efficiency-blind

Sales appeal does not depend on equipment efficiency, or is harmed by higher first cost.

Measures: Performance standards. Equipment labelling. Consumer education.

ENERGY PRODUCERS AND DISTRIBUTORS

The Supply-obsessed

Preoccupation with supplies because profits are coupled to sales.

Measures: Change of charter, or regulation, to force producers to provide least-cost energy services (i.e. including efficiency measures). Encouragement of diversification into efficiency-based business. Third party contracting.

The Centralization-biased and Supply Monopolists

Pre-occupation with (large-scale) centralized supply, aided by lack of competition. This discourages supply-side efficiency measures such as co-generation, as well as renewables.

Measures: Government planning, including least-cost analysis. Energy planning by local communities. Utility privatization. Legislation to encourage independent producers, with fair buy-in prices (e.g. avoided or long-run marginal costs).

GOVERNMENTS

The Uninterested

Belief that efficiency means belt-tightening conservation and is not for developing countries where energy consumption is very low.

Measures: Education of government departments involved with energy supply and end-use. Help in developing alternative least-cost energy scenarios and planning forecasts. Pressure from public and NGOs, etc.

The Unfair

Governments which tolerate unfair competition between supply investments and demand management, through subsidies, grants, R & D expenditures, and other benefits and incentives.

Measures: Alter policies to create fairer competition.

The Cost-blind price-fixer

Government-controlled prices do not reflect real operating costs, so that utilities cannot raise capital from revenues, increasing their (and national) indebtedness, as well as discouraging efficiency and alternative supplies.

Measures: Increase prices (e.g. to cover long-run marginal supply costs). Efficiency improvements must be implemented along with price rises to offset the latter.

The Skills-short and Information-lacking

Government agencies lack technical and managerial skills, and information about hardware as well as the "software" measures noted above.

Measures: Extensive and intensive training and information programmes, including measures to increase access to 'best' technologies. Funding to pay for capacity development in government departments and elsewhere (local government, utilities, universities, NGOs, etc).

The Capital-short and Infrastructure-poor

Governments with these conditions typically give energy efficiency a low priority compared with more pressing development needs. However, least-cost energy provision is arguably also a pressing need: it will pay handsomely in the long (and short) run. But efficiency often depends on sound infrastructure (e.g. good roads, dependable power supplies with constant voltage, etc).

Measures: Increased international funding and technical assistance for efficiency and associated infrastructure development. A focus on maintenance and rehabilitation is often cheaper than provision of new infrastructure.

Fragmented Decision Structure

Energy efficiency involves many ministries (industry, transport, housing, agriculture, urban planning, etc) with different priorities. Coordination with the energy ministry is often weak.

Measures: Better information and departmental coordination. Least-cost energy scenarios and planning across all demand and supply sectors.

The Large is Impressive - and Lucrative - Syndrome

Large supply facilities are impressive and have a bigger political pay-off than many small efficiency schemes. They also provide more opportunities for "commissions". (This is not to say that large schemes are unnecessary, only that there may be biases towards them).

Measures: Increase public and media awareness about the best mix of projects and measures which advances true development. Least cost planning. Increase competition in the supply sector. Improved balance of project funding by aid agencies.

INTERNATIONAL FUNDING/AID AGENCIES

The Inefficiency Exporters

Donor countries export (offload) inefficient energy technologies.

Measures: Assistance on technology assessment for recipient countries. Reform of donor practices; e.g. by international agreement/convention. Fund transfers to enable recipient countries to purchase more efficient technologies where these are more costly than the inefficient.

The Large-is-Convenient Syndrome

Donor agencies are often poorly staffed and find it much easier to start up and administer a few large projects than many small ones (e.g. efficiency, small-scale renewable energy).

Measures: Donor support for recipient country agencies to administer small projects. Increase staff in donor agencies.

The Project-mode Sponsors

The "project" approach, appropriate for large-scale supply facilities, is often used as the model for efficiency and small-scale renewable energy developments where broader and flexible programme support is vital - including capacity and skills development rather than an emphasis on hardware and time deadlines.

Measures: Education of donors and recipient agencies, including learning from successful experience of programme support.

The Self-Reliance Underminers (or Dependence Perpetuators)

Donor agencies find it more convenient to use Northern institutions and experts for project assessment and management.

Measures: Use indigenous (or neighbouring country) expertise where available. Strengthen indigenous institutions and skills as a first priority of donor assistance and "technology transfer".

Source: Adapted from: Amulya Reddy 1990, Barriers to Improvements in Energy Efficiency, paper to 2nd International Workshop on "Energy and Global Climate Change", Lawrence Berkeley Laboratory, Berkeley, United States of America, October 1990.